

## **Comp 150 Final Exam Overview.**

### **Resources During the Exam**

The exam will follow the same rules as Exam 2, except you may spend 4 hours actively working on it, and you may use notes on **four** sides of 8.5x11 inch paper (either both sides of two sheets, or four sheets written on single sides). Write this as you study! I mostly want to test you on concepts, not memorized rote facts. Opcode table supplied showing both Assembler mnemonics and binary opcodes.

**Main topics that may be on the final exam: Previous exam topics on Python + a bit on client/server programming, web notes on binary arithmetic, Pip assembler, gates/circuits/truth tables, and SQL.**

1. Previous exam topics on Python
2. Formatting with local variables: `format parameter **locals()`
3. Limited topics from cgi scripting: no HTML, but I could show you the output of my `dumpcgi.cgi` script from some web page form, as an indication of what is produced by a form, and show you an alternate cgi script to receive the information, and ask you what the script prints.
4. Converting between binary and decimal (both directions!) converting between binary and hexadecimal (the easy way, both directions)
5. Read/write Pip assembler and play computer, using all instructions except AND and CPZ. Understand the use of the accumulator and symbolic variables and labels for jumps. Follow and be able to write short computational sequences and if-else or while-loop logic with Pip assembler code
6. Be able to convert individual instructions between assembler and machine language (both ways). I will post a table of op code to assembler mnemonic conversions, like 0010 MUL, so you do not have to put that in your notes. (and still be able to play computer on Pip assembler code).
7. Understand how millions of circuit elements can be created simultaneously in chip fabrication.
8. Be able to convert any way between Boolean expressions, sequential logic circuits, and truth tables.
9. Understand circuits for adders and multiplexers
10. SQL SELECT, WHERE with =, inequalities, LIKE '...%...', IN, AND (*not* join – only one table at a time)

### **Exam emphases**

1. Individual topics that are new since the last exam will be more emphasized than the topics you have been examined on before, probably meaning 45-55% of the exam will be on new topics.
2. Problems from later in the semester generally include skills needed from early in the semester implicitly, so most questions will not be straight from the early part of the course, though there may be some topics from earlier in the semester that did not get used much in the later part of the course.
3. The best characterization of the course is the course itself, but I have tried to give you tutorial work or homework on all topics, so reviewing your work is a good review. Looking at old exams or sample exams is a quick but *not complete* way to review the older material: You should have covered much more in all your work than there was space for in exams or even sample exams. Obviously if you missed something on an exam, it would be good to make sure you know it now, but exams involve a number of arbitrary choices and omissions, and different choices are likely to be made on the final. Major topics are likely to reappear, but often be treated from a somewhat different angle than last time, or combined in different ways. A mostly different collection of secondary topics is likely to be on the final.
4. I repeat: the best review of what you need to be able to do is to go over what you have worked on. If you need further exercises on any subject, let me know.

### **Same Instructions for studying and using the sample problems as on the last two exams**

1. Study first and then look at the sample problems.... See earlier review pages for the rest.

*New sample problems start on the next page.*

## Review Problems for the Final Exam (Solutions follow the problems.)

1. Write a sequence of PIP Assembler or machine code instructions that will copy the value of memory location 130 into memory location 131. (You do not need to write a whole program -- no HLT required.)

2. Convert the PIP machine code to assembler

00010100 00000111

00000101 10000000

00001111 00000000

3. Convert the PIP Assembler to Machine code

LOD 129

MUL #3

HLT

4. Play computer with the program below, completing the log at the right, showing the machine state after each instruction (including the new IP address). To save time, you may choose to show only those values that change at each line. The initial values are shown.

IP	ACCUM	X	Y
0		0	0

Address Assembler code

0 LOD #5

2 STO X

4 LOD #3

6 STO Y

8 L1: JMZ L2

10 SUB #1

12 STO Y

14 MUL #2

16 ADD X

18 STO X

20 LOD Y

22 JMP L1

24 L2: HLT

5. Convert the following code to Pip Assembler.

if X == Z:

Y = 3

else:

X = Y

Z = X + Y

6. Draw a circuit diagram that corresponds to the following Boolean expression:  $A(B + (CA)')$

A -

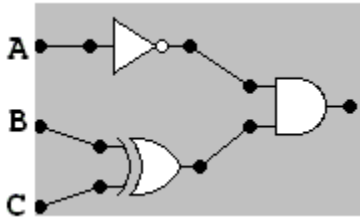
B -

C -

7. Complete the truth table below.

A	B	A'	A'B	A+B	A'B $\oplus$ (A+B)
0	0				
0	1				
1	0				
1	1				

8. Write a Boolean expression involving A, B, and C that corresponds to the following circuit:



9. Given the truth table below, write a Boolean expression in terms of A, B, and C for X.

A	B	C	X
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

11. What is printed? Be careful to follow the order of execution, not the order of the text!

```
def foo(x):           #1
    return x*2        #2

def bar(a, n):         #3
    print(foo(n+1))    #4
    print(foo(a))      #5

print('go')            #6
bar('now', 4)          #7
```

12. Do the following base conversions. Show work.

- Convert the decimal number 54 into binary.
- Convert the binary number 111100110110010010 into hexadecimal, without converting the entire base 2 representation to base 10 first.

13. Do the following base conversions. Show work.

- Convert the hexadecimal 2AF to decimal.
- Convert the decimal 844 to hexadecimal.

10. Complete the truth table if X is true whenever B is different from both A and C

A	B	C	X
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

14. Add the following binary numbers. Hint: Work place by place; add and each 2 makes a carry. Show work

```
  101011
+ 100110
```

15. What is printed? Hint: The list nums is modified while it is being referred to as newVals in foobar.

```
def foobar(oldVals, newVals): #1
    for i in oldVals:         #2
        newVals.append(i+1)   #3

nums = [6]                    #4
foobar([1, 3, 8], nums)       #5
print(nums)                    #6
```

16. What is printed? Hint:

```
def f(x):
    return 2*x + 1

print(f(1), f(f(1)))
```

17. What is printed?

```
x = 16 #1
while x > 2: #2
    x = x/2 #3
    if x > 3 and x < 7: #4
        print(3*x) #5
    else
        print(x) #6
```

18. What is printed? Be careful of the order of completion of the nested loops!

```
for s in ['abc', 'de', 'f']: #1
    for ch in s: #2
        print(ch*2, end=' ') #3
    print() #4
```

19. Write a function upper2 that takes a single string as parameter and *prints* the string twice on a line in upper case.

```
def upper2(s):
```

20. Write a function that takes a single string as parameter and *returns* the string repeated twice in upper case.

```
def upper2ret(s):
```

21. Redefine the function upper2 so it *uses* the function upper2ret.

```
def upper2(s):
```

22. Write a function printListUpper that has a parameter words, which is a list of strings, and prints each in upper case on the same line. If names were ['hi', 'there'] then the following would be printed:

HI THERE

```
def printListUpper(words):
```

25. The start of a database table is shown. Write SQL queries:

Classes				
name	section	prof	time	credits
Comp 150	1	Harrington	TTh 10AM	3
Comp 170	1	Akhtar	TTh 1PM	3
Comp 363	1	Harrington	Th 4:15PM	3

- Find the name and time for all classes with prof "Harrington"
- Find the name, prof, and time of all classes for more than 3 credits.

23. Write a function printListShortUpper that has a parameter which is a list of strings, and prints each string *that is shorter than the numeric parameter n* in upper case on the same line. If words were ['hi', 'there'] and n were 4, then the following would be printed:

HI

```
def printListShortUpper(words, n):
```

24. Write a function newListUpper that has a parameter which is a list of strings and creates and returns a new list containing each string in upper case. If words were ['hi', 'there'] then ['HI', 'THERE'] would be returned.

```
def newListUpper(words):
```

Answers on the next page

## Final Exam Review Problem Answers

1. LOD 130  
STO 131

2. LOD #7 ; pound sign from 0001; LOD code 0100; 7 from binary 00000111  
STO 128 ; STO code 0101; 128 in binary 10000000  
HLT ; HLT code is 1111

3. 00000100 10000001  
00010010 00000011  
00001111 00000000

4.	IP	ACCUM	X	Y
	0	0	0	0
	2	5	0	0
	4	5	5	0
	6	3	5	0
	8	3	5	3
	10	3	5	3
	12	2	5	3
	14	2	5	2
	16	4	5	2
	18	9	5	2
	20	9	9	2
	22	2	9	2
	8	2	9	2
	10	2	9	2
	12	1	9	2
	14	1	9	1
	16	2	9	1
	18	11	9	1
	20	11	11	1
	22	1	11	1
	8	1	11	1
	10	1	11	1
	12	0	11	1
	14	0	11	0
	16	0	11	0
	18	11	11	0
	20	11	11	0
	22	0	11	0
	8	0	11	0
	24	0	11	0
	--			

By the way, this roughly corresponds to the Python

X = 5

Y = 3

while Y != 0:

Y = Y - 1

X = X + 2\*Y

# so X ends up as 5 + 2\*2 + 1\*2 + 0\*2 = 11

5. LOD X ; same as if x-z == 0 ; or jump if not x-z == 0

SUB Z

NOT

JMZ ELSE

LOD #3

STO Y

JMP PAST

ELSE: LOD Y

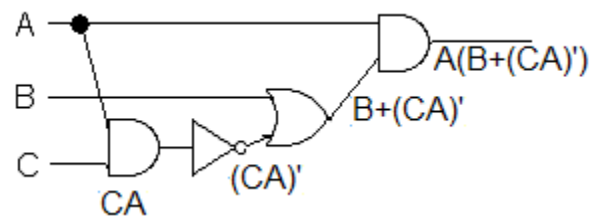
STO X

PAST: LOD X

ADD Y

STO Z

6. (Could use NAND instead of AND and NOT)



7.

A	B	A'	A'B	A+B	A'B ⊕ (A+B)
0	0	1	0	0	0
0	1	1	1	1	0
1	0	0	0	1	1
1	1	0	0	1	1

8. A'(B ⊕ C)

9. A'B'C' + A'BC + ABC

10.

A	B	C	X
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	0
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	0

11. go  
10  
nownow

```
line comment
6   print go (earlier lines only definitions)
7   Call bar
3   a is 'now' and n is 4
4   n+1 is 4+1 is 5; call foo(5)
1   x is 5
2   return 2*5 is 10
4   print returned 10
5   call foo
1   x is 'now'
2   return 'now'*2 is 'nownow'
5   print returned nownow
```

12a. 110110:  $54/2 = 27$  R 0,  $27/2 = 13$  R 1,  $13/2 = 6$  R 1,  $6/2 = 3$  R 0,  $3/2 = 1$  R 1,  $1/2 = 0$  R 1  
remainders backwards: 110110

b. 3CD92      11 1100 1101 1001 0010 group from the right!  
              3    C    D    9    2

13a  $2*16^2 + 10*16 + 15 = 512 + 160 + 15 = 687$

b.  $844/16 = 52$  R 12;  $52/16 = 3$  R 4;  $3/16 = 0$  R 3 Read remainders from right: 3 4 12; convert to hexadecimal digits: 34C. (If you do not like arithmetic with 16's, you could do binary conversions in the middle: part a: convert to binary, then decimal. Part b: convert to binary; then hexadecimal.)

14.      1 111      carries  
          101011  
+    100110  
     1010001

15. [6, 2, 4, 9]      Execution starts at line 4 -- after the definitions  
step by step – does not show the spaces and newlines, not a complete substitute for the final answer!

Line	nums	i	comment
4	[6]		
5			call foobar
1			oldVals is [1, 3, 8] and newVals is an alias for nums
2		1	i is first element of oldVals
3	[6, 2]		i+1 is 1+1 is 2, append to newVals (nums)
2		3	i is next element of oldVals
3	[6, 2, 4]		i+1 is 3+1 is 4, append to newVals (nums)
2		8	i is next and last element of oldVals
3	[6, 2, 4, 9]		i+1 is 8+1 is 9, append to newVals (nums)
2		-	done with sequence and done with loop
6			print [6, 2, 4, 9] (with square braces and commas)

16. 3 7    #  $f(1)$  is  $2*1+1 = 3$ ;  $f(f(1))$  is  $f(3) = 2*3+1=7$

```
17.  8
      12
      2
```

```
line x  comment
1   16
2      16 > 2 is True
3   8   16/2 is 8
4      8 > 3 and 8 < 7 is true and false is false
6      print 8
2      8 > 2 is True
3   4   8/2 is 4
4      4 > 3 and 4 < 7 is true and true is true
5      4*3 is 12 -- printed
2      4 > 2 is True
3   2   4/2 is 2
4      2 > 3 and 2 < 7 is false and true is false
6      print 2
2      2 > 2 false: skip loop
```

```
18.  aa bb cc
      dd ee
      ff
```

```
line s  ch  comment
1   abc  first in list
2       a  first in character sequence 'abc'
3       print aa (but stay on same line)
2       b  next in character sequence 'abc'
3       print bb (but stay on same line)
2       c  last in character sequence 'abc'
3       print cc (but stay on same line)
2       -  done with character sequence 'abc'
4       on to new line, done with inner loop
1   de   next in list for outer loop
2       d  first in character sequence 'de'
3       print dd (but stay on same line)
2       e  next and last in character sequence 'abc'
3       print ee (but stay on same line)
2       -  done with character sequence 'de'
4       on to new line, done with inner loop
1   f    next in list for outer loop
2       f  first in character sequence 'f'
3       print ff (but stay on same line)
2       -  done with character sequence 'f'
4       on to new line, done with inner loop
1       done with list and outer loop
```

```
19. def upper2(s):
      print(s.upper()*2)
```

```
25a SELECT name, time FROM classes
      WHERE prof = "Harrington"
b. SELECT name, prof, time FROM classes
      WHERE credits > 3
```

```
20. def upper2ret(s):
      return s.upper()*2
```

2

```
21. def upper2(s):
      print(upper2ret(s))
```

```
22. def printListUpper(words):
      for s in words:
          print(s.upper(), end=' ')
```

```
23. def printListShortUpper(words, n):
      for s in words:
          if len(s) < n:
              print(s.upper(), end=' ')
```

```
24. def newListUpper(words):
      up = []
      for s in words:
          up.append(s.upper())
      return up
```